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New Crayfishes (Decapoda: Parastacidae: *Euastacus*) from Northeastern New South Wales, Australia

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ABSTRACT. Routine astacological surveys in northeastern New South Wales have revealed four new species of crayfish. Three species are allied to the "*setosus* complex", a group of small and poorly spinose *Euastacus* previously recorded only from Queensland: *E. girurmulayn* n.sp. from the Nightcap Range, *E. guruhgi* n.sp. from the Tweed volcanic plug and *E. jagabar* n.sp. from the Border Ranges. These three species are differentiated chiefly on features of the sternal keel, spination and antennal squame. *Euastacus dalagarbe* n.sp., recorded from the Border Ranges, has affinities with a growing group of crayfish displaying morphological traits intermediary between the *setosus* complex and more characteristically spinose *Euastacus*. It differs markedly in spination of the chelae, and in the nature of the lateral processes of the pereiopods. All of these taxa occur in association with the much larger and more spinose *E. sulcatus*. An unusual crayfish specimen of uncertain status is also discussed.

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Recent taxonomic revision of the genus *Euastacus* (Morgan, 1986, 1988, 1997) resulted in both the description of several new species and synonymies of others, including the synonymy of the genus *Euastacoides* (Riek, 1956) with *Euastacus*. Together with a new species of *Euastacus, E. jagara*, the genus *Euastacoides* was designated by Morgan (1988) as a group of small, poorly spinose *Euastacus* (the "*setosus* complex"), not sufficiently different to warrant recognition at the generic level. Moreover, Morgan (1988, 1997) pointed out that several species bear intermediary traits between the *setosus* complex and those of the genus generally, strengthening this synonymy.

Historically there has been a paucity of sampling in the northeastern New South Wales area, resulting in few sites of taxonomic record for the three species of *Euastacus* known from the area: *E. gumar* (two proximal sites), *E. sulcatus* (two sites) and *E. valentulus* (several sites). These three species are distinct from the *setosus* complex, being medium to large in size and of moderate to strong spination. Recently, increased sampling in the region extended the distribution of *E. gumar* and *E. sulcatus* and revealed a further species, *E. mirangudjin*, morphologically intermediate between the *setosus* complex and *Euastacus* generally (Coughran, 2002).

The current paper describes four new species of *Euastacus* discovered during continued surveys of the region, one of which, *E. dalagarbe* n.sp., also bears characteristics intermediate in nature. The remaining species, *E. girurmulayn* n.sp., *E. guruhgi* n.sp. and *E. jagabar* n.sp., are allied to the *setosus* complex itself. A key to all species of *Euastacus* found in southeastern Queensland and northeastern New South Wales is provided. An unusual specimen collected during the research, which displays some characteristics of *Euastacus* yet differs markedly in structural morphology, is also discussed.

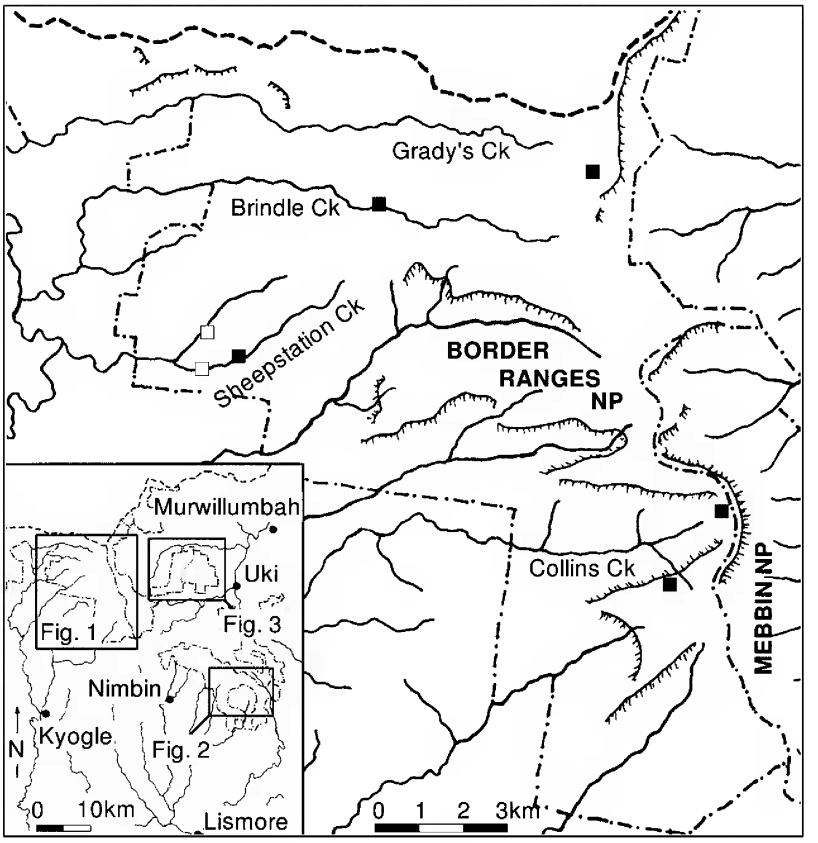

Fig. 1. Collection localities of *Euastacus dalagarbe* (black squares) and *E. jagabar* (white squares) in northeastern New South Wales. All sites are in the Border Ranges National Park. Location of collecting areas in Figs. 1–3 are shown in the inset.

Methods

Sampling involved lifting rocks and woody debris and collecting crayfish by hand. Although other methods were employed (baited traps, spotlighting, visual observation), they were only successful in catching the larger and sympatric *Euastacus sulcatus*. Collection localities are shown in Figs. 1–3. Basic water quality and habitat information was recorded, and all retained animals were transported to Southern Cross University in moist hessian sacks, before being euthanased by freezing. Specimens were fixed in 10% neutral buffered formalin for two weeks, thereafter stored in 70% ethanol. Some specimens were preserved directly in ethanol. Colour was described while animals were alive, and photographs taken of live animals to record it. Elevations were estimated from 1:25000 topographic maps, and bearings recorded with a Garmin handheld GPS (or estimated from 1:25000 topographic maps where specified).

Measurements of preserved specimens were made to the nearest 0.1 mm with dial vernier calipers, and measurements and ratios follow those used by Morgan (1986). Specimens in the process of moulting were excluded from measurements and ratios. Gastric mill characters were examined for selected specimens. Obviously regenerate chelae were not included in ratios used. Spine characteristics and other morphological traits used in the descriptions follow those of Morgan (1986). Character states that follow the latest revision of the genus (e.g., size, sharpness) have been described according to the illustrative framework provided therein (Morgan, 1986, 1988, 1989, 1997). For other character states, the term "sharp" refers to spines that are produced to a distinct point, and "blunt" to those that are not. Relative sizes of characters are provided for comparative purposes, and are standardized as "small", "medium" or "large".

Type specimens have been deposited with the Australian Museum (AM) collection. Holotypes of similar species were examined from the collections of the AM and Queensland Museum (QM), as outlined below. Other animals examined are housed in the Southern Cross University reference collection (SCU).

Comparative material. *Euastacus jagara*, holotype, QM W6471; *Euastacus maidae*, holotype, AM P12888; *Euastacus setosus*, holotype, AM P12887; *Euastacus urospinosus*, holotype, AM P12886; *Euastacus reductus*, holotype, AM P15731; *Euastacus mirangudjin*, identified material as follows: SCU KCK.gd.09, Iron Pot Ck (type locality), 3♀♀; SCU KCK.gd.10, upper reaches of Iron Pot Ck, 2♀♀; SCU KCK.gd.11, wet gully in Murray Scrub, 2♂♂, 2♀♀; SCU KCK.gd.12, Cob O'Corn Ck, 3♂♂, 3♀♀.

Euastacus dalagarbe n.sp.

Fig. 4

Type material. HOLOTYPE: AM P67884; male (OCL 35.8 mm); minor gully feeding Brindle Creek (rainforest), Border Ranges National Park, northeastern N.S.W.; 28°22.789'S 153°04.334'E; elevation 760 m; J. Coughran; 22 October 2001. PARATYPES: AM P67885; 4♂♂, 4♀♀ (OCL 9.0–32.5 mm); type locality; J. Coughran; 27 September 2001. AM P67886; 1♂, 1 aberrant male (OCL 25.1–31.3 mm); upper Collins Creek (rainforest), Border Ranges NP; 28°25.978'S 153°07.656'E; elevation 880 m; J. Coughran; 22 October 2001. AM P67887; 2♂♂, 2♀♀ (OCL 18.9–31.7 mm); upper Grady's Creek, Lost World Wilderness Area (rainforest), Border Ranges NP; 28°22.182'S 153°06.422'E; elevation 890 m; J. Coughran & D. Newell; 2 October 2003. AM P67888; 4♂♂, 3♀♀ (OCL 13.7–30.1 mm); tributary to Sheepstation Ck; Sheepstation Creek

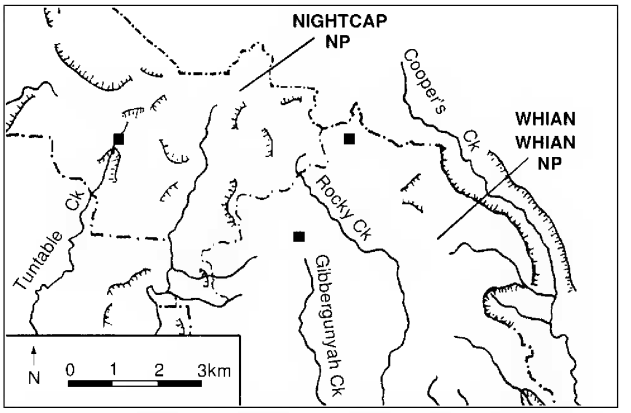

Fig. 2. Collection localities of *Euastacus girurmulayn* in northeastern New South Wales. The previous Whian Whian State Forest has been designated as National Park since collection.

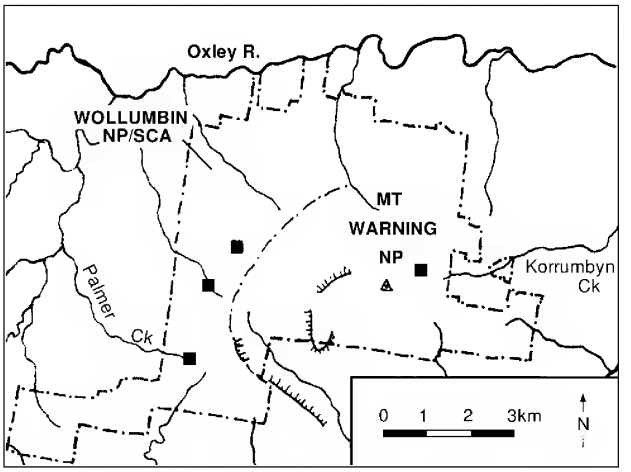

Fig. 3. Collection localities of *Euastacus guruhgi* in northeastern New South Wales. The previous Wollumbin State Forest has been designated as National Park and State Conservation Area since collection.

Fig. 4. *Euastacus dalagarbe*. Dorsal view, holotype, AM P67884. Photograph: Max Egan. Scale bar is 10 mm.

Flora Reserve (rainforest), Border Ranges NP; 28°24.085'S 153°02.247'E; elevation 570 m; J. Coughran & D. Newell; 28 November 2003. AM P67913; 1♂, 2♀♀ (OCL 21.4–30.1 mm); un-named wet gully, Bar Mountain (rainforest), Border Ranges NP; 28°27.500'S 153°07.710'E (topographic map); elevation 960 m; J. Coughran & D. Newell; 28 November 2003.

Type locality. The type locality is in a minor gully feeding Brindle Creek, a westward-flowing tributary of the upper Richmond River, approximately 30 km north of Kyogle. One paratype (32.5 mm male) is the only specimen caught in Brindle Creek itself, despite repeated sampling. While Brindle Creek is large (up to 10 m in width), this animal was collected from a shallow, quiet backwater of Brindle Creek, seasonally fed by a minor gully. All other specimens (including several released after capture) were found in small gullies and tributaries feeding Brindle, Collins, Grady's and Sheepstation Creeks. These watercourses are typically very small in nature, and often nearly or completely void of surface water for a considerable part of the year.

Other specimens examined. SCU KCK.gd.13; 1 ♀ (OCL 33.6 mm); type locality; J. Coughran; July 2003. SCU KCK.gd.14; 3♀♀ (OCL 14.2–19.3 mm); upper Collins Creek (rainforest); 28°25.978'S 153°07.656'E; elevation 880 m; J. Coughran; 22 October 2001. Several other specimens collected from the Brindle Creek sites were examined briefly before being returned to the water.

Diagnosis. Male cuticle partition present. Rostrum short, usually reaching to base or midlength of third antennal segment. Thoracic spines absent. Li abdominal spines either absent or present as 1–3 barely discernible bumps or small and blunt spines on abdominal somite 2, occasionally 1 bump also on somites 3–4. Lii spines, D-L spines, D spines and abdominal boss absent. 3 mesial carpal spines. 1 ventromesial carpal spine present on normal chelae, distinctly smaller than ventral carpal spine. Ventrolateral propodal spine row absent. Dorsal surface of propodus lateral to dactylar base without bumps, spines or protrusions. Ventrally, 1 small to medium and blunt spine lateral to dactylar base. 0–2 (usually 1) small dorsal apical propodal spines. 0–3 (usually 1–2) spines above propodal and dactylar cutting edges, spines apical in distribution. Spines ventral to propodal and dactylar cutting edges absent. Usually 1 apical mesial dactylar spine. Other apical dactylar spines and dactylar basal spines absent.

Description. Maximum OCL: 35.8 mm. —*Rostrum*. Rostrum short, reaching to base or midlength of third antennal segment, almost to anterior edge of segment on largest specimen. Rostral margins parallel to slightly convergent. Rostrum broader on specimens from Brindle Creek. Rostral carinae short. Usually 2–4 marginal spines

per side (one specimen with 1 spine on one side), rounded and decreasing in size proximally. Acumen similar in size to largest marginal spines. OCL/carapace length: 0.83–0.88. Rostral width/OCL: 0.15–0.21. —*Cephalon*. Some animals with 1 blunt cephalic spine, absent on some specimens and 2–3 spines on some specimens. Few to numerous smaller, blunt and anteriorly-directed bumps ventral to cephalic spine present on all specimens. First postorbital spine small to medium and blunt. Second postorbital spine absent. Basipodite spines absent. Coxopodite spines generally small. Interantennal spine broad, with 1–3 (usu. 2) bumps or spines per side and a prominent, blue apex. Suborbital spine barely discernible to small. Antennal squame inflated at, or distal to, midlength, and lacking marginal spines. Interantennal scale length/OCL: 0.08–0.13. —*Thorax*. 3–5 small cervical spines per side, barely discernible on some specimens. Cervical spines flattened and blunt. Thoracic spines absent. General tubercles small to medium in size and moderate to densely distributed. Areola length/OCL: 0.35–0.39. Areola width/OCL: 0.16–0.22. Carapace width/OCL: 0.46–0.54. Carapace depth/OCL: 0.46–0.52. —*Abdomen*. Li abdominal spines either absent or present as 1–3 barely discernible bumps or very small and blunt spines on abdominal somite 2. Two specimens with 1 barely discernible bump on somites 3 and 4. Li spines and bumps often discernible mainly by paler colouration. Lii spines, D-L spines and D spines absent. Abdominal boss absent. Abdomen width/OCL: 0.46–0.52. OCL/total length: 0.38–0.42. —*Tailfan*. Standard tailfan spines generally small to medium. Telsonic and uropodal surface and marginal spines absent. Telson length/OCL: 0.32–0.38. —*Keel*. Pair 1 usually close, slightly apart on some specimens, and parallel to slightly closed. Pair 2 close, slightly apart or apart and usually slightly open or parallel, closed on one specimen. Pair 3 narrow to medium breadth and with gradual margins. Pair 4 broad. —*Chelae*. Usually intermediate in shape, elongate on paratype. Regenerating chelae usually elongate. *Merus*. 4–8 small and blunt spines. *Carpus*. 3 mesial carpal spines, distalmost distinctly larger and sharper than, and offset ventrally to, other spines. Two specimens with a fourth minute mesial carpal spine on one claw, and one specimen from Bar Mountain with 2 spines (distalmost absent). Ventral carpal spine large and sharp. A single, blunt ventromesial spine present, much smaller than ventral spine. Regenerate chelae of Collins Creek specimens with 1–2 additional ventromesial carpal spines. Usually 1 (occ. 2) insignificant lateral carpal spines, discernible mainly by pale colour. Dorsal carpal spines absent. Dorsal carpal groove deep. *Propodus*. Dorsal lateral propodal spine row extending to between ½ and ⅔ of propodal length from apex (reaching entire length of propodus on regenerate chela of one specimen). Ventrolateral propodal spine row absent (1 barely discernible spine on regenerate chela of one specimen from Collins Creek). 3–5 mesial propodal spines (6 on one regenerate chela from Collins Creek). Mesial propodal spines usually numbering 4, with a distinct gap between first spine (at distal edge of propodal palm) and second spine. Spine at distal edge of palm often poorly developed. Specimens from Grady's Creek, Sheepstation Creek and Bar Mountain with 5 mesial propodal spines. Dorsal propodal surface lateral to dactylar base usually distinctly smooth (some minor development of protuberances on some Bar Mountain specimens). Ventrally, 1 small, blunt spine lateral to dactylar base (absent on one regenerate chela). 1–2 small dorsal apical propodal spines (usually 1), occasionally absent. 2–3 blunt bumps dorsally at dactylar articulation. Spines posterior to dactylar articulation absent. Spines above propodal cutting edge either absent or numbering 1–2 (3 on some regenerate chelae), if present spines small and apical. Spines ventral to propodal cutting edge absent. Propodal length/OCL: 0.89–1.14. Propodal width/propodal length: 0.41–0.47. Propodal depth/propodal length: 0.25–0.34. *Dactylus*. Usually 1–2 small spines above dactylar cutting edge on dorsal surface (absent on one specimen; 0 or 3 on some regenerate chelae). Spines ventral to dactylar cutting edge absent. 1 apical mesial dactylar spine, barely discernible or small (absent on one specimen; two specimens with 2 spines on 1 chela). Other apical dactylar spines absent. Dactylar basal spines absent. Dactylar length/propodal length: 0.53–0.59. —*Punctation*. Sparse to moderate. Punctation especially sparse on dorsal region of cephalon, giving a "polished" appearance on some specimens. —*Setation*. Sparse to moderate, short, stiff setae on thorax, cervical groove and lateral cephalic regions. —*Gastric Mill*. TAP count 3.5; TAA count 1.0; spread 2.5. Urocardiac ridges 4–6.

Colouration. Body dark green brown to brown dorsally, tending to brown ventrally. Abdomen brown, with barely discernible Li spines paler than surrounding areas. Walking legs washed pale tan to dull orange ventrally, coxa dull orange. Postorbital spine blue with a yellow tip. Cervical and cephalic spines orange or brown. Merus and carpus of chelae dorsally green-blue, ventrally orange or tan tinged blue along mesial edge. Propodus dorsally brown to green-brown, mottled on palm and generally darker mesially. Propodus ventrally orange or brown (light blue on one animal from Bar Mountain) with green mottling, bright orange at base of fingers and around dactylar articulation. Fingers of chelae deep green-blue, tending to blue apically, especially on dorsal surface. mesial carpal spines blue with white or yellow tips. Lateral carpal, ventral carpal, ventromesial carpal and ventral meral spines yellow to orange. Mesial and lateral propodal spine rows blue, with pale yellow-green spines with white tips. Propodal and apical dactylar spines white to brown. Spine above cutting edges white to dull yellow-green.

Sexes. Males possess a cuticle partition. A 28.3 mm OCL female specimen from Grady's Ck has calcified gonopores. A further female from Grady's Ck with an OCL of 30.5 mm has gonopores which are mostly calcified but are opening (bear a small membranous portion within gonopore). A 29.3 mm OCL female from Brindle Creek has membranous gonopores with light setation around the margins. Thus, it would appear that maturity occurs close to 30 mm OCL.

Biology. The species inhabits moist gullies and small streams which are largely void of surface water for at least part of the year. They are found under rocks in the red clay of the rainforests, where they inhabit burrows into the subsurface water. It would appear that *Euastacus dalagarbe* to some extent partitions the habitat with the considerably larger and spinier species, *E. sulcatus*, the former being excluded from the larger habitat of the main creek channel. Both species can, however, occur together in the smaller habitat, and have been collected from under the same rock. *Euastacus dalagarbe* hosts small, white temnocephala.

Etymology. A blend of the Bundjalung Aboriginal words *dalagar* (mud) and *garbe* (gully) (Sharpe, 1985), describing the species' habitat.

Euastacus girurmulayn n.sp.

Fig. 5

Type material. HOLOTYPE: AM P67914; ♀ (OCL 33.9 mm); Tuntable Creek, above falls (wet sclerophyll with rainforest understorey), Nightcap National Park, northeastern N.S.W.; 28°33.234'S 153°17.785'E; elevation 460 m; J. Coughran and A. Coughran; 14 October 2002. PARATYPES: AM P67915; 1♂, 1♀ (OCL 22.4 mm, 26.8 mm); type locality; J. Coughran; 20 September 2002. AM P67916; 1♂, 1♀ (OCL 22.5, 22.6 mm); Gibbergunyah Creek (rainforest gully), Whian Whian National Park, northeastern N.S.W.; 28°34.786'S 153°20.305'E; elevation 580 m; J. Coughran; 18 October 2002; AM P67917; 1♀ (OCL 30.6 mm); unnamed gully in the Cooper's Ck catchment along North Rocks Rd (rainforest gully), Whian Whian NP; 28°33.809'S 153°21. 033'E; elevation 550 m; J. Coughran; 18 October 2002.

Type locality. The type locality is in Tuntable Creek, above the falls, in Nightcap National Park, approximately 30 km north of Lismore. The holotype was collected from a large rock at the stream margins, approximately 500 m upstream of the falls.

Diagnosis. Male cuticle partition present. Rostrum short, but usually reaching base of third antennal segment. 2–3 small and rounded rostral spines. Suborbital spine small to medium. Inflation of antennal squame narrow. Lateral cephalon with 1–4 small cephalic spines and a few smaller bumps per side. Coxopodal plate irregular, usually with a broad zone of spines forming a jagged edge to the plate. Thoracic spines absent. Usually 1–4 cervical spines per side. General tubercles small and moderately distributed. 1–4 Li spines (or bumps) usually present on abdominal somites 2–6, with large specimens bearing more spines. Other abdominal spines and abdominal boss absent. 7–12 dorsal meral spines. 4 mesial carpal spines, the distalmost being the largest, with variation in the alignment of spines. Ventrolateral propodal spine row absent. Spines above propodal cutting edge usually absent (1 specimen with 1 spine). 0–1 dorsal apical propodal spines. 4–5 mesial propodal spines. 1 small and blunt spine above dactylar cutting edge. 1 apical mesial dactylar spine. A single spine lateral to dactylar base ventrally. Dactylar groove distinct. Lateral processes with moderate to well-defined margins. Keel Pair 2 close and parallel to open. Keel posterior to pair 3 reduced and deflated at sides, forming a narrow ridge.

Fig. 5. *Euastacus girurmulayn*. Dorsal view, holotype, AM P67914. Photograph: Max Egan. Scale bar is 10 mm.

Description. Maximum OCL: 33.9 mm. —*Rostrum*. Rostrum short, usually just reaching base of third antennal segment (extending only to midway of second antennal segment on one animal from Gibbergunyah Ck). Rostral carinae short to medium length, convergent at sides and divergent at base. 2–3 rostral marginal spines per side. Spines varying in location along the rostrum, with four possible spine locations evident and all animals lacking spines in some positions (and often unequal on different sides of the rostrum). Acumen slightly larger than marginal spines and rounded. Rostral carinae short. OCL/carapace length: 0.87–0.90. Rostral width/OCL: 0.15–0.18. —*Cephalon*. Usually 1–4 small cephalic spines, and a few smaller bumps. First postorbital spine small to medium and blunt to moderately pointed. Second postorbital spine absent. Basipodite spines usually absent, but animals from Tuntable Ck with a small spine on one or both sides. Coxopodal plate irregular, usually with a broad zone of spines forming a jagged edge to the plate, or with two large, triangular teeth; in extreme cases, plate looking grossly misshaped (North Rocks gully animal). Interantennal scale elongate to medium. Scale margins usually smooth (one animal from Tuntable Ck slightly toothed). Suborbital spine small to medium. Antennal squame lacking marginal spines and with narrow inflation, at or slightly posterior to midlength. Interantennal scale length/OCL: 0.07–0.10. —*Thorax*. 1–4 cervical spines per side on most specimens (absent on specimen from North Rocks gully). Thoracic spines absent. General tubercles small and moderately distributed. Areola parallel or only slightly incurved at centre. Areola length/OCL: 0.34–0.38. Areola width/OCL: 0.15–0.18. Carapace width/OCL: 0.47–0.51. Carapace depth/OCL: 0.37–0.42. —*Abdomen*. Li spines absent on somite 1. Usually 1–4 vague bumps or blunt spines in the Li position on abdominal segments 2–6, although all specimens bar the holotype lack spines on some segments. Holotype with 2–4 small spines on somite 2, 3–4 small spines on somites 3–5 and 1 spine on somite 6. Li spines absent on one small specimen from Gibbergunyah Ck. Lii spines, D-L spines and D spines absent on all specimens. Abdomen width/OCL: 0.44–0.48. OCL/total length: 0.41. —*Tailfan*. Standard tailfan spines medium. Telsonic and uropodal surface and marginal spines absent. Telson length/OCL: 0.3–0.34. —*Keel*. Pair 1 close and parallel. Pair 2 close and parallel to open. Pair 3 narrow to medium breadth, and with gradual posterior margins (elongate). Pair 4 broad.

Keel posterior to pair 3 reduced and deflated at sides, forming a narrow ridge. All lateral processes with moderate to well-defined margins. —*Chelae*. Elongate to stout. Regenerate chelae usually more elongate than normal chelae. *Merus*. 7–12 small and poorly developed spines. *Carpus*. 4 mesial carpal spines, with some differentiation between populations as to the alignment. In animals from Tuntable Ck, only the first (distalmost) spine is offset ventrally. The first and third mesial carpal spines are offset ventrally in the animal from North Rocks gully, and only the fourth spine is offset ventrally in the Gibbergunyah Ck animals. Ventral carpal spine small and blunt. 1–3 ventromesial carpal spines on normal chelae, extending in a row from ventral spine towards the second mesial carpal spine. Ventromesial carpal spines increasing in size mesially, with the outermost being immediately ventral to, and similar in size to, the second mesial carpal spine. A single lateral spine present at distal edge of carpus, insignificant or small. Dorsal carpal spines absent. Dorsal carpal groove deep. *Propodus*. Dorsal lateral propodal spine row extending from apex to midlength or as far as ⅔ of propodal length (spines notably smaller and blunter on the specimen from North Rocks gully). Ventrolateral propodal spine row absent. 4–5 mesial propodal spines, usually 4 with a distinct gap between first (at distal edge of propodal palm) and second spines. Spines in some positions indistinct or damaged. 1 spine lateral to dactylar base dorsally (absent on one regenerate chela). 1 small spine lateral to dactylar base ventrally. 1 small dorsal apical propodal spine on most specimens, absent on some animals. Holotype with 1 large spine on one chela and 2 small spines on the other. 2 large, blunt bumps at dactylar articulation dorsally, more pronounced on the specimens from Tuntable Ck. Spines posterior to dactylar articulation absent. Precarpal spines absent. Spines above propodal cutting edge (dorsal surface) usually absent (holotype with 1 apical spine on one chela and 1 at midlength on other). Propodal length/OCL: 0.75–0.92. Propodal width/propodal length: 0.43–0.48. Propodal depth/propodal length: 0.28–0.33. *Dactylus*. 1 small, blunt spine above dactylar cutting edge on dorsal surface, absent on smaller specimens. 1 medium and blunt apical mesial dactylar spine (spines small on one specimen from Gibbergunyah Ck). Other apical dactylar spines and dactylar basal spines absent. Dactylar groove distinct. Dactylar length/propodal length: 0.56–0.62. —*Punctation*. Sparse and shallow on cephalon, less distinct and sparser laterally. Punctation on chelae also sparse but more distinct. —*Setation*. Setation light on body and abdomen, moderate on walking legs. Dense clumps of long, uneven setae protruding from punctures in chelae, especially on fingers. Distinctive bristly setation around and on lateral processes of pereiopods, and around coxa of pereiopods of some animals. —*Gastric Mill*. TAP count 3.0–3.5; TAA count 1.0; spread 2.0–2.5. Urocardiac ridges 4.

Colouration. Body dorsally brown, with lateral branchiostegites lighter (often a rich tan colour). Animals often with blue patches on lateral cephalon above anterior end of cervical groove. Body ventrally cream. Walking legs cream or pale purple-grey, with cream coxa. Carpus and propodus light brown dorsally with a distinct, darker veining pattern. Fingers dark brown, tending blue or cream apically. Carpus ventrally orange-brown, tinged blue-brown mesially and brown laterally. Propodus ventrally cream-brown or pale bluish-grey with a darker veining pattern of brown or blue, orange-brown or green-brown near dactylar articulation and with blue or cream finger-tips.

Sexes. Males possess a cuticle partition. The large female from Tuntable Ck (33.9 mm OCL) is mature, with soft, membranous gonopores heavily fringed with setae. Other females, including the 30.6 mm OCL animal from North Rocks gully, have closed gonopores without setae, suggesting that maturity occurs in females after reaching 30 mm OCL.

Biology. The species was collected from somewhat different habitats at each of the three populations. Tuntable Ck is a small, permanent stream with a gravel and cobble bed overlying solid bedrock. The animals were collected from under rocks at the stream margins or on exposed shoulders. The gully along North Rocks Road lacks surface water entirely, and the animal was collected from under a rock next to the road culvert. The Gibbergunyah Ck site is high in the headwaters of the creek, and the habitat consists of a few basaltic cobbles and boulders and dense vegetative debris over fine, red earth. At this site, animals were collected from under cobbles and palm fronds, and even from under the same frond as a larger specimen of *E. sulcatus*, which is also present at Tuntable Ck. *Euastacus girurmulayn* hosts small, white temnocephala.

Etymology. From the Bundjalung Aboriginal words *girur* (smooth, slippery) and *mulayn* (crayfish) (Sharpe, 1985). In general terms, this is the least spinose member of the *setosus* complex.

Euastacus guruhgi n.sp.

Fig. 6

Type material. HOLOTYPE: AM P67926; ♀ (OCL 25.2 mm); Korrumbyn Creek, adjacent to visitor carpark (rainforest), Mount Warning National Park, northeastern N.S.W.; 28°23.875'S 153°16.893'E; elevation 410 m; J. Coughran and A. Coughran; 12 April, 2002. PARATYPES: AM P67918; male (OCL 23.5 mm); type locality; J. Coughran and A. Coughran; 12 April 2002. AM P67919; 1♂, 2♀ (OCL 17.0–32.5 mm); un-named creek running parallel to Brummies Rd (rainforest), Wollumbin National Park, northeastern N.S.W.; 28°23.587'S 153°13.875'E; elevation 320 m; J. Coughran; 5 September 2002. AM P67920; 1♂, 1♀ (OCL 24.8 mm, 22.4 mm); un-named gully along North Wollumbin Rd (rainforest), Wollumbin NP; 28°23.304'S 153°14.013'E; elevation 440 m; J. Coughran; 5 September 2002. AM P67921; 1♀ (OCL 17.5 mm); Palmer Creek (rainforest), Wollumbin NP; 28°24.723'S 153°13.705'E; elevation 430 m; J. Coughran; 5 September 2002.

Type locality. The type locality is in the main creek adjacent to the visitor carpark at Mt Warning National Park, approximately 15 km southwest of Murwillumbah. The holotype was collected approximately 200 m upstream of the intersection of the creek and the walking track.

Diagnosis. As for *E. girurmulayn*, except: Rostrum varying in length, extending to the midlength of the second antennal segment or as far as the anterior tip of the third antennal segment. 2–4 small, blunt rostral spines per side. Antennal squame lacking marginal spines and inflated at or slightly distal to midlength. Li abdominal spines usually just discernible. 4–8 just discernible or small dorsal meral spines. 1 dorsal apical propodal spine. Dactylar groove absent or shallow. Lateral processes with blunt to moderate margins. Keel Pair 2 slightly apart and slightly open. Keel posterior to pair 3 usually broad and strongly developed, and fusing smoothly with the lateral processes of the third and fourth pereiopods.

Description. Maximum OCL: 32.5 mm. —*Rostrum*. Rostrum varying considerably in length, extending to midlength of second antennal segment or as far as the anterior end of the third antennal segment. Rostral carinae short, convergent at sides and divergent at base. 2–4 small to medium and blunt rostral marginal spines per side. Acumen usually similar in size to, or slightly larger than, marginal spines (acumen smaller than marginal spines on the specimen from Palmer Ck). Rostral carinae short to medium length. OCL/carapace length: 0.87–0.90. Rostral width/OCL: 0.12–0.18. —*Cephalon*. 2–4 medium cephalic spines, and a few smaller bumps, per side. First postorbital spine usually medium to large and blunt (small on specimens from North Wollumbin gully). Second postorbital spine absent. 1 small to medium basipodite spine present. Specimens from Mt Warning and Palmer Ck have basipodite spines on the right hand side only. Coxopodite irregular, either with 2 large spines (Mt Warning specimens), or a broad zone of small spines giving a serrate edge. Interantennal scale broad, margins smooth. Suborbital spine small to medium. Antennal squame lacking marginal spines and inflated at or slightly distal to midlength. Inflation narrow to moderate and reduced on left hand side on some animals from "Brummies" Ck and the North Wollumbin Rd gully. Interantennal scale length/OCL: 0.06–0.10. —*Thorax*. Cervical spines usually barely discernible, but largest animal with 4 small spines. Thoracic spines absent. General tubercles small to medium and moderately distributed. Areola incurved at centre. Areola length/OCL: 0.35–0.39. Areola width/OCL: 0.14–0.16. Carapace width/OCL: 0.49–0.54. Carapace depth/OCL: 0.38–0.44. —*Abdomen*. Usually 1 just discernible Li spine or bump on abdominal somites 3–6 (absent on small specimens). Somite 2 with 2–4 just discernible or small Li spines (absent on some specimens). Lii spines, D-L spines and D spines absent. Abdomen width/OCL: 0.44–0.52. OCL/total length: 0.40–0.44. —*Tailfan*. Standard tailfan spines medium. Telsonic and uropodal surface and marginal spines absent. Telson length/OCL: 0.3–0.37. —*Keel*. Pair 1 close and parallel. Pair 2 slightly apart and slightly open (apart and open on Mt Warning specimens). Pair 3 narrow to medium breadth, and with gradual posterior margins (more elongate). Pair 4 medium to broad. Keel between pairs 3 and 4 broad and strongly developed, and fusing with the lateral processes of the pereiopods, giving a swollen appearance. Lateral processes with blunt to moderate margins, in extreme situations giving a swollen appearance to the sternum. —*Chelae*. Intermediate to stout (regenerate chelae more elongate). *Merus*. 4–8 just discernible to small, and poorly developed, dorsal meral spines. *Carpus*. Usually 4 mesial carpal spines, first (distalmost) and third spines offset ventrally to second and fourth. Some regenerate chelae have 3 spines, and one animal has 3 spines on a normal chela and 4 on a regenerate chela. Ventral carpal spine small to medium, barely discernible on some small animals. Some regenerate chelae lack ventral carpal spines. 3–4 small to medium and blunt ventromesial carpal spines on normal chelae (regenerate chelae usually with two spines, although one regenerate chela with 5 spines). Ventromesial spines extending in a row from ventral spine towards the second mesial carpal spine, and increasing in size mesially, with the outermost being immediately ventral to, and similar in size to, the second mesial carpal spine. A single lateral spine present at distal edge of carpus, insignificant or small. Dorsal carpal spines absent. Dorsal carpal groove deep. *Propodus*. Dorsal lateral propodal spine row extending from apex to as far as ⅔ of propodal length (to around midlength on most specimens). Ventrolateral propodal spine row absent. Usually 4 mesial propodal spines, with a distinct gap between first (at distal edge of propodal palm) and second spines. One specimen from Mt Warning has 5 distinct mesial propodal spines, and some regenerate cheale have 3 or 5 spines. Usually 1 spine lateral to dactylar base dorsally. Some chelae with 2 spines, and one specimen from "Brummies" Ck has 5 spines on a normal chela. Another specimen from "Brummies" Ck has 1–2 spines and some additional small bumps lateral to the dactylar base. Usually 1 barely discernible to small spine lateral to dactylar base ventrally (one specimen from "Brummies" Ck has 2 spines; spines usually smaller or absent on regenerate chelae). 1–2 small to medium dorsal apical propodal spines (absent on small animal from Palmer Ck). 2 large, blunt bumps at dactylar articulation dorsally. Spines posterior to dactylar articulation absent. Precarpal spines absent. Spines above propodal cutting edge (dorsal surface) absent (1 spine on

Fig. 6. *Euastacus guruhgi*. Dorsal view, holotype, AM P67926. Photograph: Max Egan. Scale bar is 10 mm.

one chela of one specimen from "Brummies" Ck). Propodal length/OCL: 0.78–0.98. Propodal width/ Propodal length: 0.45–0.52. Propodal depth/propodal length: 0.31–0.37. *Dactylus*. Usually 1 small and blunt spine above dactylar cutting edge on dorsal surface. The large specimen from "Brummies" Ck bears 3 spines above dactylar cutting edge on its normal chela. 1 small to medium apical mesial dactylar spine (absent on one normal chela, and 2 spines on one regenerate chela). Other apical dactylar spines and dactylar basal spines absent. Dactylar groove absent or shallow. The dactylus is proportionally longer in the specimens from Mt Warning. Dactylar length/propodal length: 0.51–0.53 (Palmer Ck, "Brummies" Ck, North Wollumbin Rd gully); 0.62–0.66 (Mt Warning). —*Punctation*. As for *E. girurmulayn*. —*Setation*. Light on body, moderate on abdomen. Dense clumps of long, but uneven, setae protruding from punctures in chelae, especially on fingers. Distinctive bristly setation around and on lateral processes of pereiopods, and around coxa of pereiopods of some animals. —*Gastric Mill*. TAP count 3.0–3.5; TAA count 1.0–2.0; spread 1.5–2.5. Urocardiac ridges 3–6.

Colouration. Body dorsally brown to green-brown. Cephalothorax (and to a lesser extent abdomen) laterally lighter, often a rich golden-brown. Body ventrally pink and cream. Walking legs blue-grey. Carpus and propodus brown or green-brown dorsally and with a darker veining pattern (less distinct than in *E. girurmulayn*). Fingers bluish apically. Carpus, propodus and fingers variable in ventral colour: specimens from Mt Warning NP predominantly brown, with small and varying amounts of blue; specimens from Wollumbin NP predominantly blue with only minor brown wash across palm near dactylar articulation. Darker veining pattern evident on ventral propodal surface of all specimens.

Sexes. Males possess a cuticle partition. The female from Mt Warning (25.2 mm OCL) has soft, membranous gonopores with lightly setose margins. All other females (17.5–22.4 mm OCL) have calcified gonopores which lack setae. It would appear that female maturity occurs near 25 mm OCL.

Biology. *Euastacus guruhgi* occurs in rainforested gullies and streams draining the Tweed volcanic plug. Specimens were collected from under rocks and debris, and were found together with *E. sulcatus* at all sites. *Euastacus guruhgi* hosts small, white temnocephala.

Etymology. From the Bundjalung Aboriginal word *guruhgi* (swollen) (Sharpe, 1985), describing the inflated, swollen appearance of the sternal keel and lateral processes.

Euastacus jagabar n.sp.

Fig. 7

Type material. HOLOTYPE: AM P67933; ♀ (OCL 28.9 mm); a small tributary to Sheepstation Creek (rainforest), Border Ranges National Park, northeastern N.S.W.; 28°23.900'S 153°01.500'E (topographic map); elevation 430 m; J. Coughran and S. Waddington; 16 January 2002. PARATYPES: AM P67923; 2♀♀ (OCL 18.5, 23.5 mm); Sheepstation Creek (rainforest), Border Ranges NP; 28°24.546'S 153°01.462'E; elevation 330 m; J. Coughran; 17 October 2001. AM P67924; 1♂, 1♀ (OCL 18.8 mm, 19.3 mm); Sheepstation Creek (rainforest), Border Ranges NP; 28°24.546'S 153°01.462'E; elevation 330 m; J. Coughran; 5 December 2001. AM P67922; 1♀ (OCL 22.4 mm); type locality; J. Coughran and S. Waddington; 16 January 2002.

Type locality. The type locality is in a small gully adjoining the main tributary of Sheepstation Creek on the Rosewood Loop circuit, Border Ranges NP, approximately 25 km north of Kyogle. The stream connects with Sheepstation Ck below the falls.

Other specimens examined. A small male specimen (OCL 12.6 mm; SCU KCK.gd.16) retained on 16 January 2002 from a minor stream feeding Sheepstation Ck was also briefly examined.

Diagnosis. As for *E. girurmulayn*, except: Rostrum short, often not reaching base of third antennal segment. 2–3 small and rounded rostral spines, extending to rostral base. Antennal squame inflation very pronounced and at midlength, almost triangular in shape. Lateral cephalon poorly spinose, with only a few small, blunt bumps per side. Cervical spines absent. Li abdominal spines absent or present as 1–3 small and blunt bumps on somite 2, occasionally a slight bump on somites 3 and 4 also. 6–8 small dorsal meral spines. 1 dorsal apical propodal spine. Dactylar groove shallow. Keel Pair 2 slightly apart. Keel Pair 3 deflated laterally and with moderate posterior margins.

Description. Maximum OCL: 28.9 mm. —*Rostrum*. Rostrum short, usually not reaching base of third antennal segment (just reaching on two specimens). Rostral carinae sides convergent and bases divergent. 2–3 small, rounded rostral marginal spines per side, with a distinct gap between first and second spines. Acumen similar in size to marginal spines. Rostral carinae short. OCL/carapace length: 0.87–0.89. Rostral width/OCL: 0.15–0.18. —*Cephalon*. A few small or barely discernible, blunt cephalic spines per side. First postorbital spine medium and blunt. Second postorbital spine absent. Basipodite spines absent, holotype with 1 medium and blunt spine on one side. Coxopodite spines small to medium in size and blunt. Interantennal scale elongate (broad on one specimen). Holotype bears a small spine in the centre of the scale, giving the impression of a second broad scale overlying the true scale. Scale margins smooth. Suborbital spine small to medium. Antennal squame lacking marginal spines and inflated at or slightly posterior to midlength, with inflation appearing almost triangular in shape. Interantennal scale length/OCL: 0.06–0.09. —*Thorax*. Cervical and thoracic spines absent. General tubercles small and moderate to dense. Areola incurved at centre. Areola length/OCL: 0.34–0.38. Areola width/OCL: 0.18–0.19. Carapace width/OCL: 0.48–0.52. Carapace depth/OCL: 0.45–0.47. —*Abdomen*. Li abdominal spines either absent or present as 1–3 barely discernible bumps or small and blunt spines on abdominal somite 2. Holotype with 1 barely discernible bump on somites 3 and 4. When present, Li spines and bumps often discernible mainly by blue colouration. Lii, D-L and D spines absent. Abdomen width/OCL: 0.44–0.46. OCL/total length: 0.41–0.43. —*Tailfan*. Standard tailfan spines highly variable, absent or small to medium. Telsonic and uropodal surface and marginal spines absent. Telson length/OCL: 0.3–0.36. —*Keel*. Pair 1 usually close, slightly apart on paratype, and parallel. Pair 2 slightly apart and parallel to open. Pair 3 narrow to medium breadth, deflated laterally and with moderate posterior margins (i.e. not elongate posteriorly). Pair 4 broad. Keel between pairs 3 and 4 moderate in development. Lateral processes with well-defined margins. —*Chelae*. Intermediate to stout, paratype with an elongate regenerate chela. *Merus*. 6–8 small to medium, blunt spines. *Carpus*. 4 mesial carpal spines, first (distalmost)

and third spines offset ventrally to second and fourth. Ventral carpal spine small to medium (absent on one specimen), and blunt. 1–4 small to medium and blunt ventromesial carpal spines, and 1 large ventromesial carpal spine immediately ventral to carpal spines (this large and moderate ventromesial carpal spine is much larger than ventral spine, being similar in size to the mesial carpal spines). Lateral carpal spines absent or insignificant, and discernible mainly by colour. Dorsal carpal spines absent. Dorsal carpal groove deep. *Propodus*. Dorsal lateral propodal spine row extending from apex to as far as ⅔ of propodal length (to around midlength on most specimens). Ventrolateral propodal spine row absent. 4 mesial propodal spines, with a distinct gap between first (at distal edge of propodal palm) and second spines. 1 small spine and occasionally some irregular bumps and punctations lateral to dactylar base dorsally. 1 barely discernible to small spine lateral to dactylar base ventrally. 1 small dorsal apical propodal spine on most specimens, holotype with an extra barely discernible spine on one chela only, paratype with an extra barely discernible spine on both chelae. 2 large, blunt bumps at dactylar articulation dorsally. Spines posterior to dactylar articulation absent. Precarpal spines absent. Spines above propodal cutting edge (dorsal surface) absent (1 barely discernible spine on one chela of holotype). Propodal length/OCL: 0.77–0.9. Propodal width/propodal length: 0.43–0.48. Propodal depth/propodal length: 0.29–0.33. *Dactylus*. 1 small, blunt spine above dactylar cutting edge on dorsal surface. 1 small to medium and blunt apical mesial dactylar spine. Other apical dactylar spines and dactylar basal spines absent. Dactylar groove present. Dactylar length/propodal length: 0.53–0.56. —*Punctation*. As for *E. girurmulayn*. —*Setation*. Sparse on body, moderate on abdomen. Dense clumps of long, but uneven, setae protruding from punctures in chelae, especially on fingers. Distinctive bristly setation around and on lateral processes of pereiopods, and around coxa of pereiopods on some animals. —*Gastric Mill*. TAP count 3.0–3.5; TAA count 1.0; spread 2.0–2.5. Urocardiac ridges 4.

Colouration. Body dorsally varying from rich tan-brown to dark blue-black, tending to deep green-brown, green-blue or blue on cephalon. Lateral branchiostegites usually paler and tan brown. Small patches of blue in between abdominal pleura and between thorax and abdomen (on first abdominal somite). Prominent, royal blue patches on lateral cephalon above anterior end of cervical groove ("cheek spots"). Body ventrally cream, lavender and/or blue. Walking legs lavender to blue, with pale pink-white coxa. Third, fourth and fifth lateral processes of pereiopods blue to lavender. Carpus and propodus ranging from tan and green to blue-black dorsally. Carpus ventrally with a pink to blue base, tinged green mesially and brown laterally. Apical half of propodal finger pale blue, to a lesser extent on dactylar finger also. Propodus ventrally pale pink to blue, with a deeper blue veining pattern, orange-brown or green-brown across dactylar articulation and ventrolaterally along propodal finger. Apical ⅔ of both fingers blue ventrally.

Sexes. Males possess a cuticle partition. When examined under the dissecting scope, the only male specimen caught was found to have thick strands of gelatinous material extruding from the gonopores, suggesting that he was mature. This specimen had an OCL of 18.8 mm. This would appear, therefore, to be a very small species of crayfish.

Fig. 7. *Euastacus jagabar*. Dorsal view, holotype, AM P67933. Photograph: Max Egan. Scale bar is 10 mm.

However, small "precocious" males have been described in *Euastacus* (Turvey & Merrick, 1997), and this specimen may also represent a similar case. The female holotype (28.9 mm OCL) differs only marginally in relative abdomen width to all other specimens, and has only minor setal development around the gonopores, which are still calcified. All other females (18.5–23.5 mm) have closed gonopores lacking setae. Thus, an onset of maturity near 30 mm OCL, at least in females, would seem likely.

Biology. The species occurs in shallow areas at the water's edge in minor tributaries, sidestreams and shallow edge habitat of Sheepstation Creek, immediately upstream of the falls, and in a major tributary. Sampling activities directly upstream, in the Sheepstation Creek Flora Reserve, yielded only specimens of *E. dalagarbe* and *E. sulcatus*. *Euastacus jagabar* is sympatric with *E. sulcatus*, a much larger and spinier species. It is likely that the two species partition the stream habitat, with the larger species inhabiting the deeper water in addition to the shallow areas, and the much smaller *E. jagabar* being restricted to shallower habitat throughout its life-cycle.

Etymology. From the Bundjalung Aboriginal language, *jagabar* is the same word used to describe blue, black, blue-black and dark (Sharpe, 1985), all of which are true of this species.

Discussion

Were it not for a slightly increased development of the abdominal and ventrolateral propodal spines and a regular ventromesial carpal spination, *Euastacus dalagarbe* would be placed within the *setosus* complex itself. Of the species outside the complex, it is perhaps most similar to *E. mirangudjin*, and notably so in colour. *Euastacus dalagarbe* is readily distinguished from *E. mirangudjin* in that the latter has greatly increased spination above the dactylar and propodal cutting edges. *Euastacus mirangudjin* can be further distinguished in that it has a row of well-developed spines ventral to the propodal cutting edges (i.e. on the underside of the chelae), a feature absent in all other poorly spinose species examined herein. Unlike *E. mirangudjin*, the propodal palm lateral to the dactylar base is distinctly smooth in *E. dalagarbe*, and the propodal fingers with fewer apical spines. The lateral processes of the fifth pereiopods are different between the two species. In *E. mirangudjin* the processes are fused together at the base and concave in profile, forming a distinct cup-shaped depression, and the posterior margins are fringed with long setae that terminates posteriorly in a mat of long setae. In *E. dalagarbe* the processes are not fused and lack the distinct depression, being strongly convex in profile. In addition, the posterior margins of the processes are not fringed with setae, and the terminal mat of setae is distinctly shorter, in *E. dalagarbe*.

Field sampling has not revealed any geographically or morphologically intermediate species between *E. mirangudjin* and *E. dalagarbe*, and although each species has been recorded from several sites they are each morphologically uniform across their known ranges. *Euastacus mirangudjin* occurs on the Richmond Range, and *Euastacus dalagarbe* on the Tweed Range. The only species recorded during the study in between these areas are the much larger and spinier *E. sulcatus* and *E. valentulus*. Although both *E. dalagarbe* and *E. mirangudjin* are somewhat similar to *E. reductus* (from the Port Macquarie region), morphologically *E. dalagarbe* is distinctly more similar to the *setosus* complex animals.

Largely because they lack many of the features integral to the taxonomy of the genus (i.e. spines), the geographically distinct taxa *E. girurmulayn, E. guruhgi* and *E. jagabar* are rather similar in general appearance. However, they differ in morphology of the sternum, antennal squame, dactylus and coxopodal plate (Table 1, Figs. 8–9). The antennal squame character is of particular interest. Morgan (1988) found variation in squamal shape between species in the *setosus* complex, and accordingly dismissed it as a generically diagnostic character. The enormous variation within the present species is also supportive of this.

In addition to those features listed in the table, other minor differences are evident. Specimens of *E. guruhgi* and *E. jagabar* have distinctly incurved areolar grooves (i.e. hour-glass shaped), with a row of large punctations mesial to each groove. These punctations are distinctly larger than the general punctations, and sprout setae which is longer and clumped (i.e. two or three setae per punctation). In contrast, *E. girurmulayn* animals have only moderately incurved or parallel areolar grooves, and exhibit poor development of the large pores. The ventral ear of the zygocardiac ossicle differs in *E. guruhgi* in that it is pronounced anteriorly and very uneven (jagged) posteriorly. However, general development of both the ear and the ossicle has been found to be inconsistent in some specimens of both *E. girurmulayn* and *E. guruhgi*, with a striking lack of bilateral symmetry in some animals. The taxa also differ

Table 1. Morphological features distinguishing the three species *Euastacus girurmulayn* (Nightcap Range), *E. guruhgi* (Tweed volcanic plug) and *E. jagabar* (Border Ranges). The species also differ in colouration.

feature	*Euastacus girurmulayn*	*Euastacus guruhgi*	*Euastacus jagabar*
antennal squame	narrow inflation	narrow to moderate inflation, slightly reduced on left hand side of some animals	very broadly inflated at midlength, almost triangular in shape
coxopodite antennal spines	irregular, either a broad zone of sharp spines or two large triangular teeth	irregular, either a broad zone of sharp spines or two large triangular teeth	regular, small to medium and rounded
lateral processes of pereiopods	sharply defined margins	blunt margins	moderate to sharply defined margins
lateral processes of Pr2	close	slightly apart to apart	slightly apart to apart
lateral processes of Pr3	intermediate to elongate posteriorly; not deflated	elongate posteriorly; not deflated	abrupt posteriorly; deflated laterally
lateral processes of Pr3 & Pr4	defined from keel	poor definition from keel; swollen appearance	defined from keel
sternal keel between pereiopods 3 and 4	deflated laterally, forming a narrow ridge, and shallow	broad and deep, and fused smoothly with lateral processes of Pr3 & Pr4	moderate in development
dactylar groove	distinct	absent or shallow	shallow
merus (dorsal spines)	7–12 spines	4–8 spines	6–8 spines

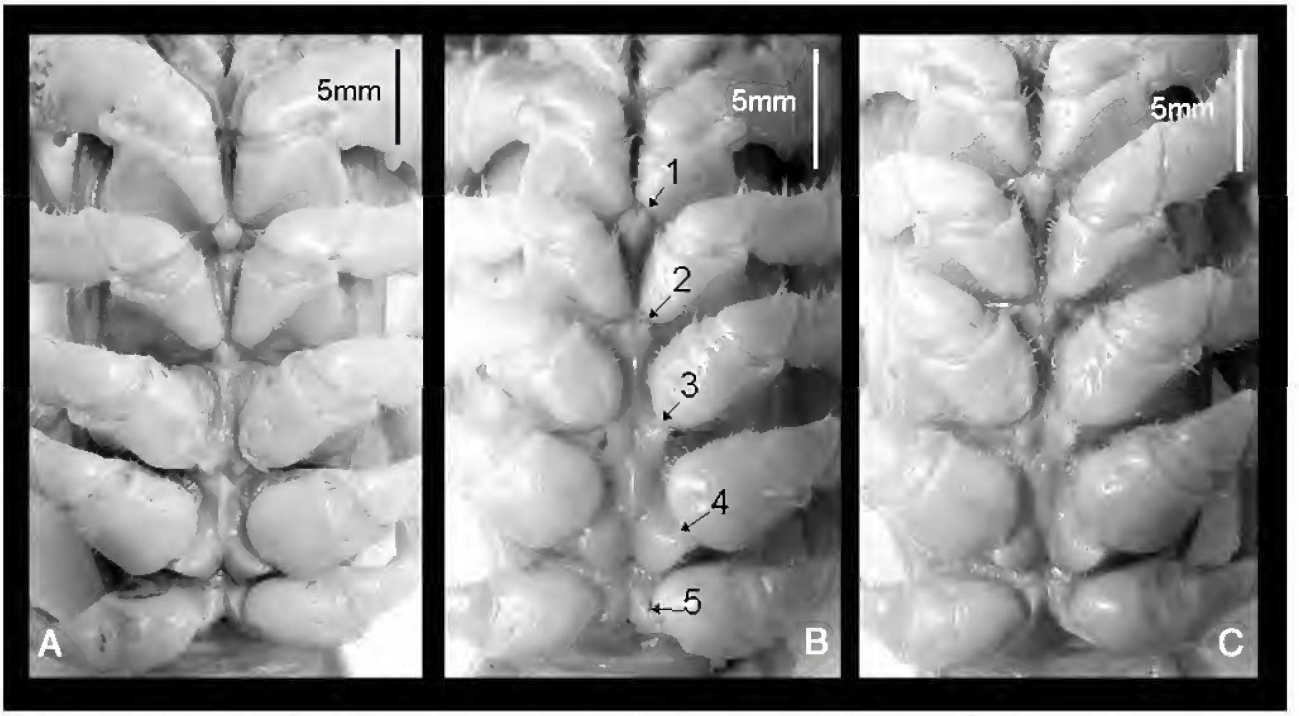

Fig. 8. Distinguishing features of the sternal keels and lateral processes to the pereiopods in the three species *Euastacus girurmulayn, E. guruhgi* and *E. jagabar*. Lateral process pairs (LPr1–5) are numbered in the centre image. (*A*) *Euastacus girurmulayn* has close and parallel LPr2, a deflated keel between the LPr3 and LPr4, and well-defined margins to the keel and processes. (*B*) *Euastacus guruhgi* has slightly apart to apart and open LPr2, very gradual posterior margins in the LPr3, a broad and deep keel between the LPr3 and LPr4, and blunt margins to the keel and processes. (*C*) *Euastacus jagabar* has slightly apart to apart and open LPr2, laterally deflated LPr3, moderate development of the keel between the LPr3 and LPr4, and moderate development and margins to the keel and processes. Photographs are of holotypes (AM P67914; AM P67926; AM P67933).

in colouration, and the veining pattern on the chelae is distinctly more pronounced in *E. girurmulayn*. There may also be differences in size at sexual maturity, at least in females. Females of *E. girurmulayn* and *E. jagabar* near 30 mm OCL bear immature gonopore characters, yet, at just over 25 mm OCL, the largest female *E. guruhgi* bears mature gonopores.

Of particular interest in the *E. girurmulayn, E. guruhgi* and *E. jagabar* taxa is the large spine immediately ventral to the mesial carpal spine row, a feature which is invariable across all specimens of all species. It differs, however, on the holotypes of the remaining members of the complex. There are no similar spines on *E. setosus, E. urospinosus* or *E. jagara*. A similarly large spine is present in *E. maidae*, but in a distinctly more ventral position. *Euastacus maidae* does, however, bear a considerably smaller spine posteromesial to this spine, located immediately ventral to the mesial row between the second and third spines. Thus, although different in nature to that of *E. girurmulayn, E. guruhgi* and *E. jagabar, E. maidae* also bears a ventromesial carpal spine immediately ventral to the mesial spine row. Morgan (1988) considered a large "mesoventral" carpal spine on *E. fleckeri* and *E. robertsi* (from far northern Queensland) as being one of several traits differentiating those species from the rest of *Euastacus*. If these distinctive carpal spines on either *E. maidae* or the present species are homologous with the mesoventral spine on the "*fleckeri* complex", a most interesting link is provided which may be of importance to our understanding of that complex too.

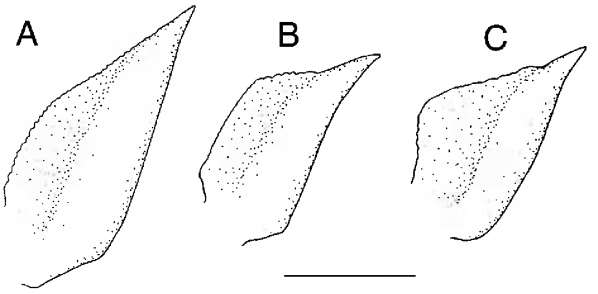

Fig. 9. Comparison of antennal squame: (*A*) *Euastacus girurmulayn*, holotype, AM P67914; (*B*) *E. guruhgi*, holotype, AM P67926; and, (*C*) *E. jagabar*, holotype, AM P67933. Scale bar represents 2 mm. Sketches: Shane Ahyong.

All of the presently described taxa can be differentiated from *E. sulcatus*, with which they are all sympatric, by the absence of the ventrolateral propodal spine row and the presence of three to four mesial carpal spines. *Euastacus girurmulayn, E. guruhgi* and *E. jagabar* can be further distinguished by the large ventromesial carpal spine immediately ventral to the carpal spines. *Euastacus sulcatus* is also much more spinose generally. Unlike the new taxa, small (and large) specimens of *E. sulcatus* usually bear considerable armature in the suborbital, postorbital, and cervical spine positions, and have much larger eyes relative to the body size (in comparably sized specimens). The following key has been adapted from those provided by Morgan (1986, 1997) to facilitate identification of *Euastacus* from northeastern New South Wales and southeastern Queensland.

Preliminary key to the species of *Euastacus* found in northeastern New South Wales and southeastern Queensland

Thoracic spines may be small, blunt, and visible only with strong lighting. They are best observed in animals over 20 mm OCL. Recently collected specimens of an undescribed *Euastacus* species allied to the larger, spiny species group are included in the following key as *Euastacus* sp. 1.

1 Ventrolateral propodal spine usually well developed, with 4 or more spines. Either thoracic spines or dactylar basal spines present. Animals >30 mm OCL with medium to large abdominal spines 2

—— Ventrolateral propodal spine row poorly developed, with fewer than four spines, or absent. Thoracic and dactylar basal spines absent (if thoracic spines present, then only as 1–3 spines just posterior to cervical spines). Abdominal spination poorly developed 7

2(1) Thoracic spines absent ..... *Euastacus sulcatus*

—— Thoracic spines present 3

3(2) Lateral spines present on outer ramus of uropod. Distribution north of Brisbane (Conondale Ranges area) ..... *Euastacus hystricosus*

—— Lateral uropodal spines absent. Distribution south of Brisbane 4

4(3) Dactylar basal spines usually present. Distribution west of the Clarence River 5

—— Dactylar basal spines usually absent (occasionally present on regenerate chelae, or on one chela only). Distribution east of the Clarence River 6

5(4) Telsonic surface spines present on animals >40 mm OCL. Thoracic spines yellow, orange or red. Rostral marginal spines usually apical or extending to midlength of rostrum. Setation light to moderate ..... *Euastacus suttoni*

—— Telsonic surface spines absent. Thoracic spines dark brown. Rostral marginal spines usually extending to base of rostrum. Setation heavy ..... *Euastacus* sp. 1

6(4) Thoracic spines large. 3 or 4 apical mesial dactylar spines. Ventral colour of propodus blue ..... *Euastacus valentulus*

—— Thoracic spines small to medium. 1 or 2 apical mesial dactylar spines. Ventral colour of propodus orange ..... *Euastacus gumar*

7(1) Spines above propodal cutting edge and dactylar cutting edge usually extending over more than ½ of chela gape, often spanning the entire length of gape (especially on propodus). A row of spines also present ventral to the propodal cutting edge (i.e. on the ventral surface of the chelae) ..... *Euastacus mirangudjin*

—— Spines above propodal and dactylar cutting edges usually absent, or, if present, only 1–3 apical spines. Spines ventral to propodal cutting edge absent 8

8(7) Usually a single ventromesial carpal spine present. Ventral carpal spine distinctly larger than ventromesial carpal spines ..... *Euastacus dalagarbe*

—— More than one ventromesial carpal spine, some of which distinctly larger than ventral carpal spine 9

9(8) The most mesial of the ventromesial carpal spines not located immediately ventral to the second mesial carpal spine 10

—— The most mesial of the ventromesial carpals spines distinctly the largest, and located immediately ventral to the second mesial carpal spine, to which it is of similar size (or larger) 13

10(9) Suborbital spine large to very large ..... *Euastacus setosus*

—— Suborbital spine small to medium 11

11(10) 6–7 mesial carpal spines ..... *Euastacus jagara*
—— 4 mesial carpal spines 12

12(11) Distalmost mesial carpal spine much smaller than other spines ..... *Euastacus urospinosus*
—— Distalmost mesial carpal spine largest ..... *Euastacus maidae*

13(9) Dactylar groove distinct. Lateral processes of the second pereiopods close. Sternal keel usually deflated between pereiopods 3 and 4, forming a narrow ridge. 7–12 dorsal meral spines ..... *Euastacus girurmulayn*
—— Dactylar groove shallow. Lateral processes of the second pereiopods slightly apart or apart. Sternal keel not deflated between pereiopods 3 and 4. 4–8 dorsal meral spines 14

14(13) Sternal keel broad and deep, and fused smoothly with lateral processes of third and fourth pereiopods, giving a swollen appearance. Lateral processes to the pereiopods with very blunt margins. Antennal squame inflation moderate ..... *Euastacus guruhgi*
—— Sternal keel moderately developed, and not fused with lateral processes of third and fourth pereiopods. Lateral processes to the pereiopods with well-defined margins. Antennal squame inflation pronounced, almost triangular in shape ..... *Euastacus jagabar*

Systematics

Euastacus dalagarbe belongs to a growing number of species bearing intermediary traits between the *setosus* complex and those of more characteristically spinose *Euastacus*. The species lacks a ventrolateral propodal spine row, has poor abdominal spination, and is poorly spinose around the thorax, cephalon and chelae generally. *Euastacus girurmulayn, E. guruhgi* and *E. jagabar* belong within the complex and are most similar to *E. maidae*, differing chiefly in ventromesial carpal spination. In addition, *E. maidae* differs in having more developed cephalic, cervical, post-orbital, abdominal and meral spination generally, more elongate carpal spines, and a serrate margin to the interantennal scale. *Euastacus girurmulayn, E. guruhgi* and *E. jagabar* could be considered as the least spinose members of the "spiny crayfish" genus *Euastacus*.

The discovery of another intermediary species, *E. dalagarbe*, further strengthens the synonymy of *Euastacoides* with *Euastacus* (Morgan, 1988), particularly so given that it is much closer to the complex itself than the remaining species in the intermediary group. It is also noteworthy that the distribution of a member of the *setosus* complex, *E. jagabar*, is in such close proximity to the distribution of *Euastacus dalagarbe*, a species bearing intermediary traits. As such, the southern end of the general distribution of the *setosus* complex as a whole (southeastern Queensland and northeastern New South Wales) now coincides with the northern end of the distribution of known species displaying intermediary traits. This is most interesting for our overall understanding of the *setosus* complex, which appears to be considerably larger and more widespread than previously thought. There are many gaps in the geographic distributions of species in both the complex and the intermediary group. It is quite likely that further research in Queensland and New South Wales will reveal more currently undescribed species which further add to our understanding of these small, poorly spinose *Euastacus*.

An unusual crayfish specimen (SCU.KCK.gd.15; male; 21.8 mm OCL; Fig. 10) has been collected from a site proximal to the type locality of *E. dalagarbe* during this study. The animal bears a number of traits of *Euastacus*, such as lateral propodal spines (weakly developed), a membranous posterior to the telson and simple genital papillae. However, the cephalothorax is strongly compressed and very deep, the abdomen is depressed, and the branchiostegal groove does not immediately fuse with the cervical groove on one side. The coxae of the pereiopods are more pronounced in development, and both the body and pereiopods are distinctly elongate. There is an unusually large gap between the rostrum and the antennae, and the antennal squame are long and quite odd in shape. It is conceivable that the specimen is a hybrid between *E. dalagarbe* and *E. sulcatus*, although this would not explain why it bears such significant features that are uncommon to both. In the absence of any further material it is not possible to resolve this issue at present. However, it may be of importance in the broader systematics of the Parastacidae, and efforts to collect further specimens would be highly desirable. Unfortunately, I have been unable to obtain further specimens despite repeated attempts. The single specimen was caught at night under a rock in a tributary to Brindle Ck, during wet weather in October 2002.

Conservation Status. All the new taxa appear to have restricted distributions. Much attention has been directed towards the conservation status of Australian freshwater crayfishes in recent years (Horwitz, 1990, 1995; Merrick, 1993, 1995; Morgan, 1997), and the genus *Euastacus* is perhaps the most threatened, with over one third of the species warranting conservation attention (see Horwitz, 1995). The upland *Euastacus* species, confined to remnant natural vegetation in highland areas, are threatened by habitat loss and fragmentation (Horwitz, 1990). Despite the fact that all of the present species occur in national parks, the uncertainty of their conservation status should be viewed as a concern. Although national parks are not reserved solely for conservation purposes (National Parks & Wildlife Service, 2001), the discovery of new species should be viewed as a significant increase to the conservation value of all parks in this study. The recent designation of the prior Whian Whian and Wollumbin State Forests as National Parks may be significant to the survival of *E. girurmulayn* and *E. guruhgi*, respectively.

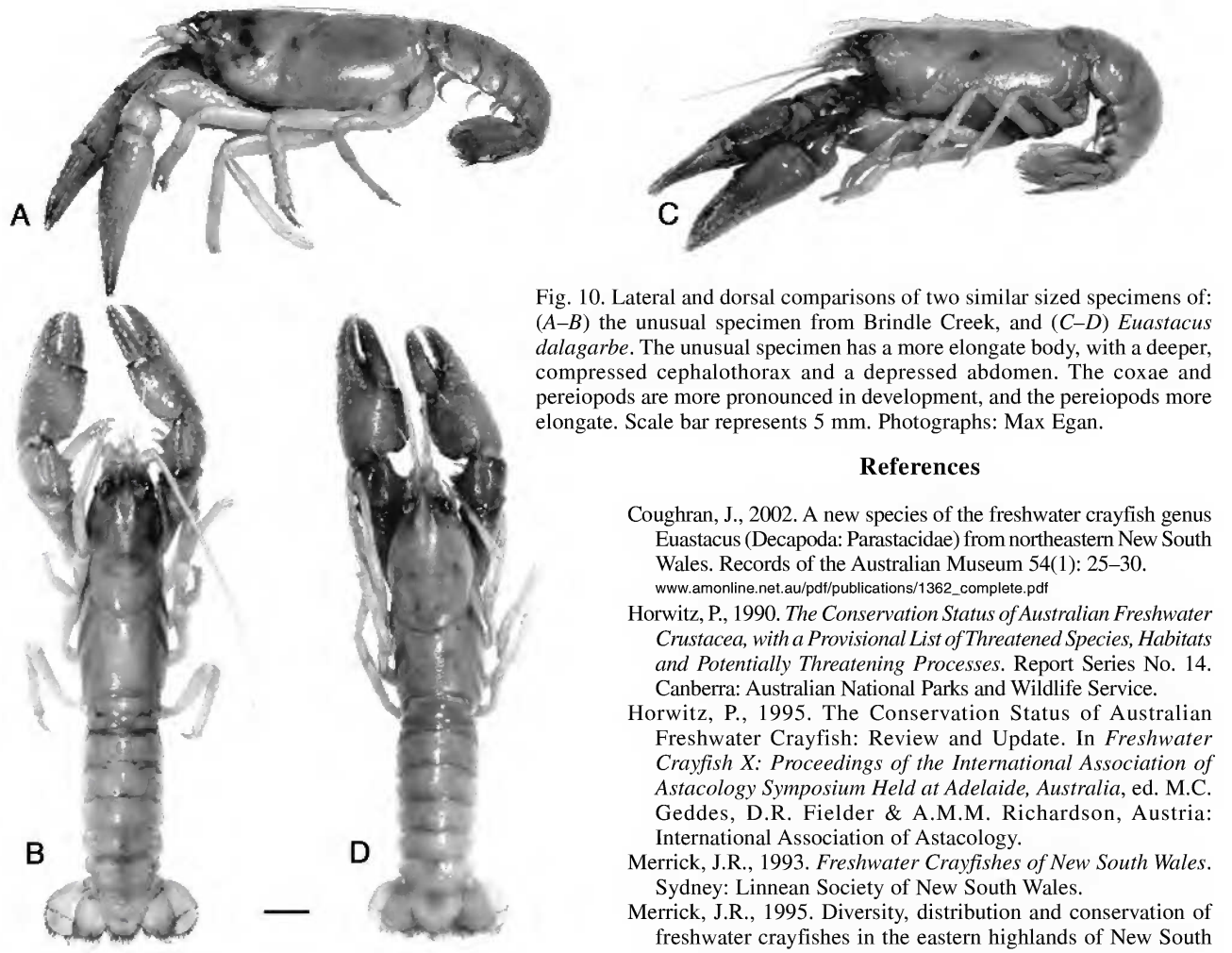

Fig. 10. Lateral and dorsal comparisons of two similar sized specimens of: (*A–B*) the unusual specimen from Brindle Creek, and (*C–D*) *Euastacus dalagarbe*. The unusual specimen has a more elongate body, with a deeper, compressed cephalothorax and a depressed abdomen. The coxae and pereiopods are more pronounced in development, and the pereiopods more elongate. Scale bar represents 5 mm. Photographs: Max Egan.

It is conceivable that all of the presently described taxa are endemic to, and perhaps dependent on the remnant habitat provided by, these parks. However, even national parks are not exempt from anthropogenic influences, including the impacts from management, visitation and illegal activities. Poaching of crayfish from Brindle Creek (i.e. within the park and adjacent to the type locality for *E. dalagarbe*) has been observed during sampling in this study. In addition to being known from only small geographic areas, these species are found in very low abundance. This may be attributable to the presence of the much larger *E. sulcatus* at the type localities. Ecological research is required to ascertain the conservation status of *E. dalagarbe, E. girurmulayn, E. guruhgi* and *E. jagabar*.

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